



# **Tevatron Magnet Studies**

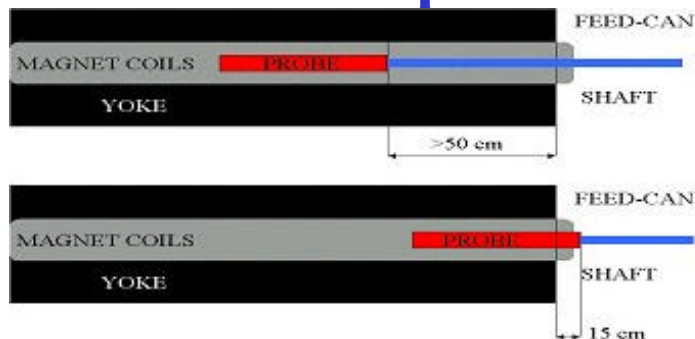
***Pierre Bauer***

- **b2 drift and snapback in Tevatron dipoles**
- **drift of a1 in Tevatron dipoles**
- **drift of b0 in Tevatron dipoles**
- **(geometric) skew quad in Tevatron dipoles (& change thereof on ramp)**
- **other activities**

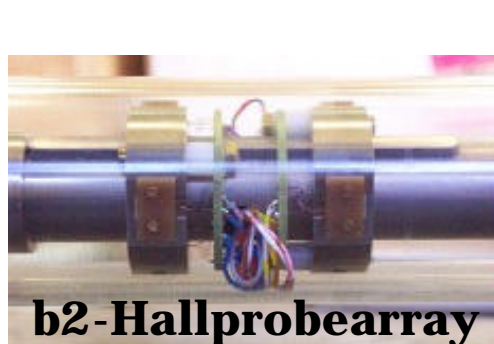
# **Magnetic Measurements at the Magnet Test Facility**



- 1m, 5Hz rot. coil system (dip, quad & tang. coils)
- Sextupole Hall-probe - ~10 Hz for snapback



Rotating coil  
drive-system



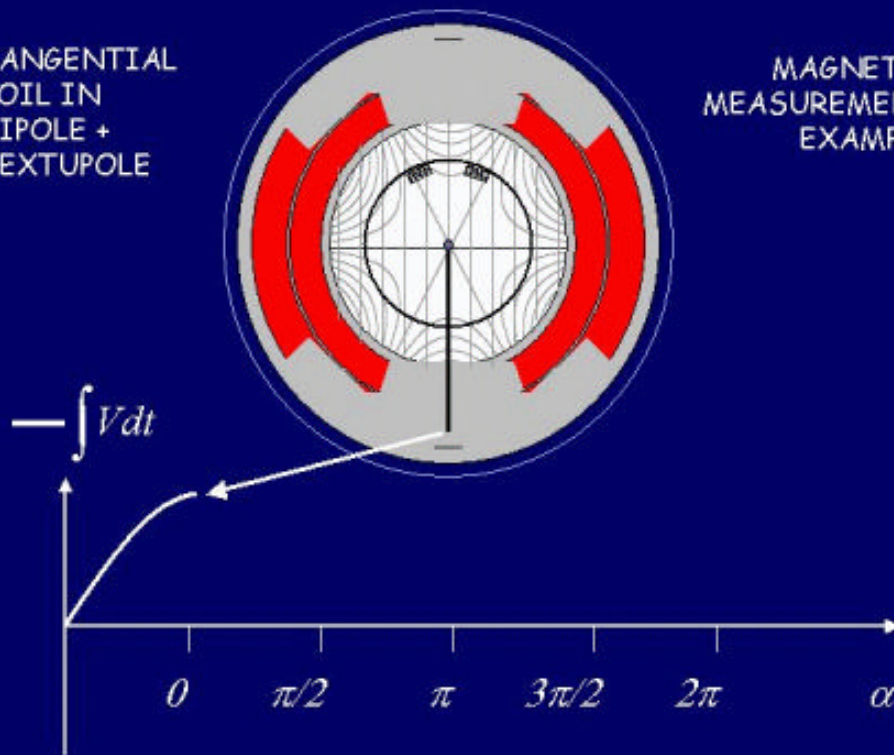
b2-Hallprobe array



Tevatron dipole on  
MTF test stand

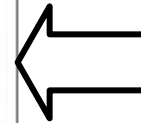
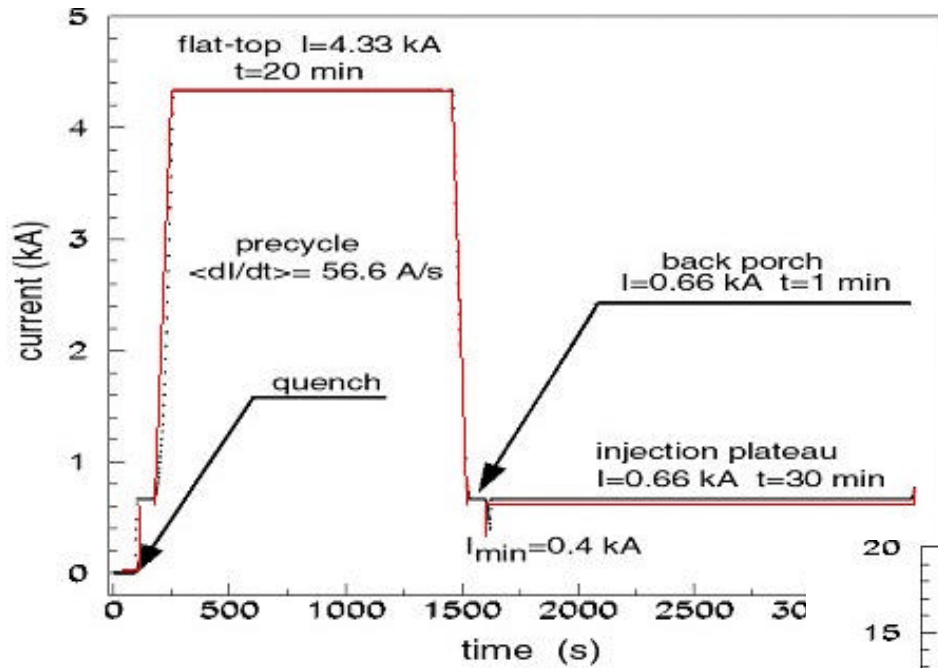
TANGENTIAL  
COIL IN  
DIPOLE +  
SEXTUPOLE

MAGNETIC  
MEASUREMENT  
EXAMPLE



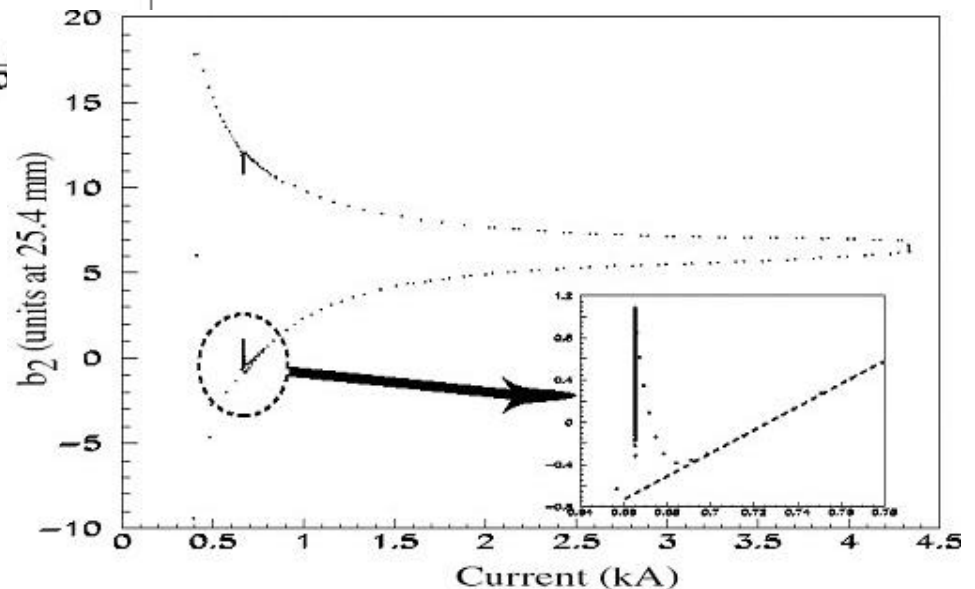


## **Magnetic Measurement Example**



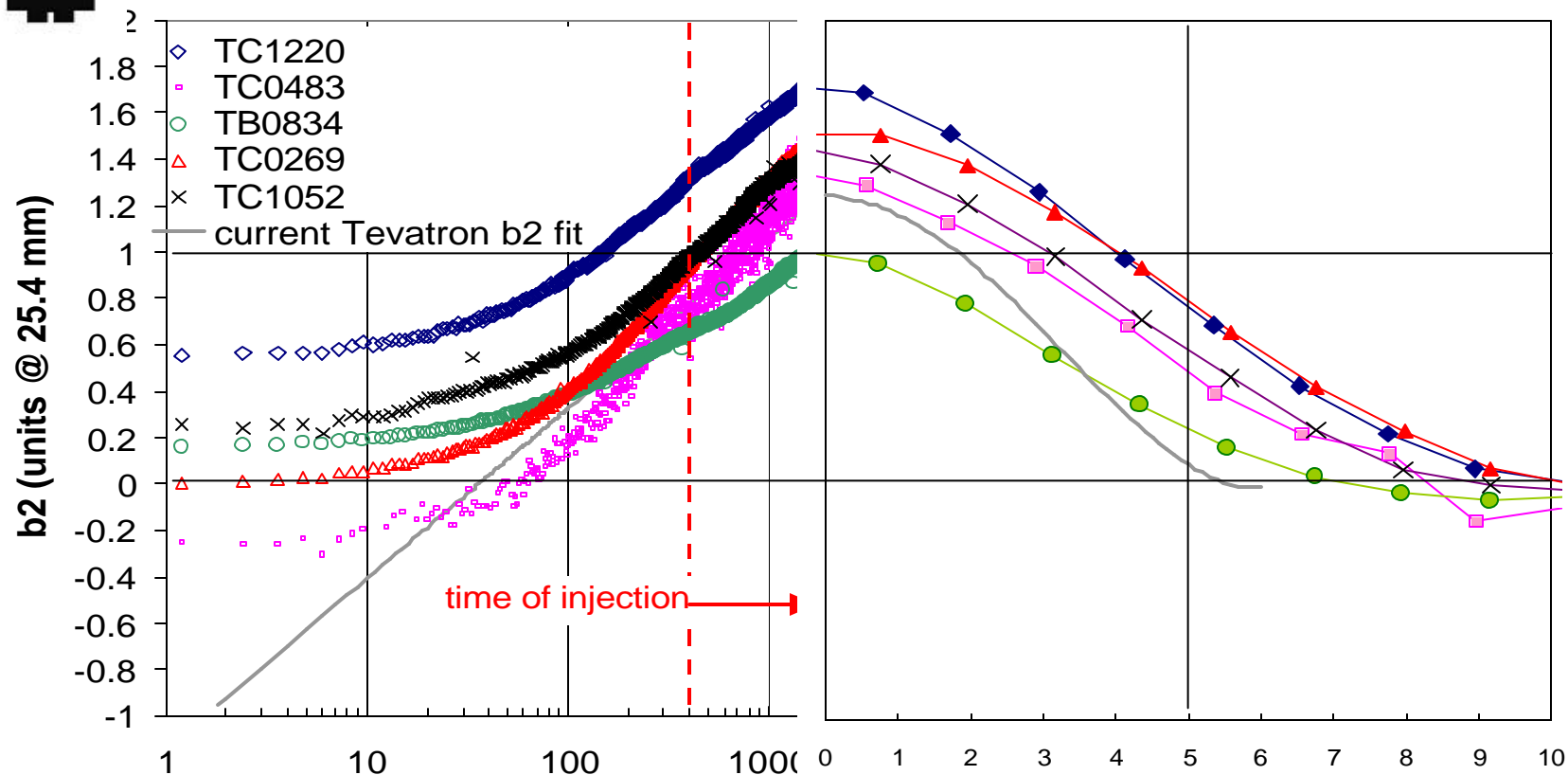
**Measurement ramping cycle = current Tevatron operation cycle and variations (of the pre-cycle parameters).**

**b2 loop & b2 drift/SB 30 min injection porch**





# *Dynamic b2 in Tevatron Dipoles*



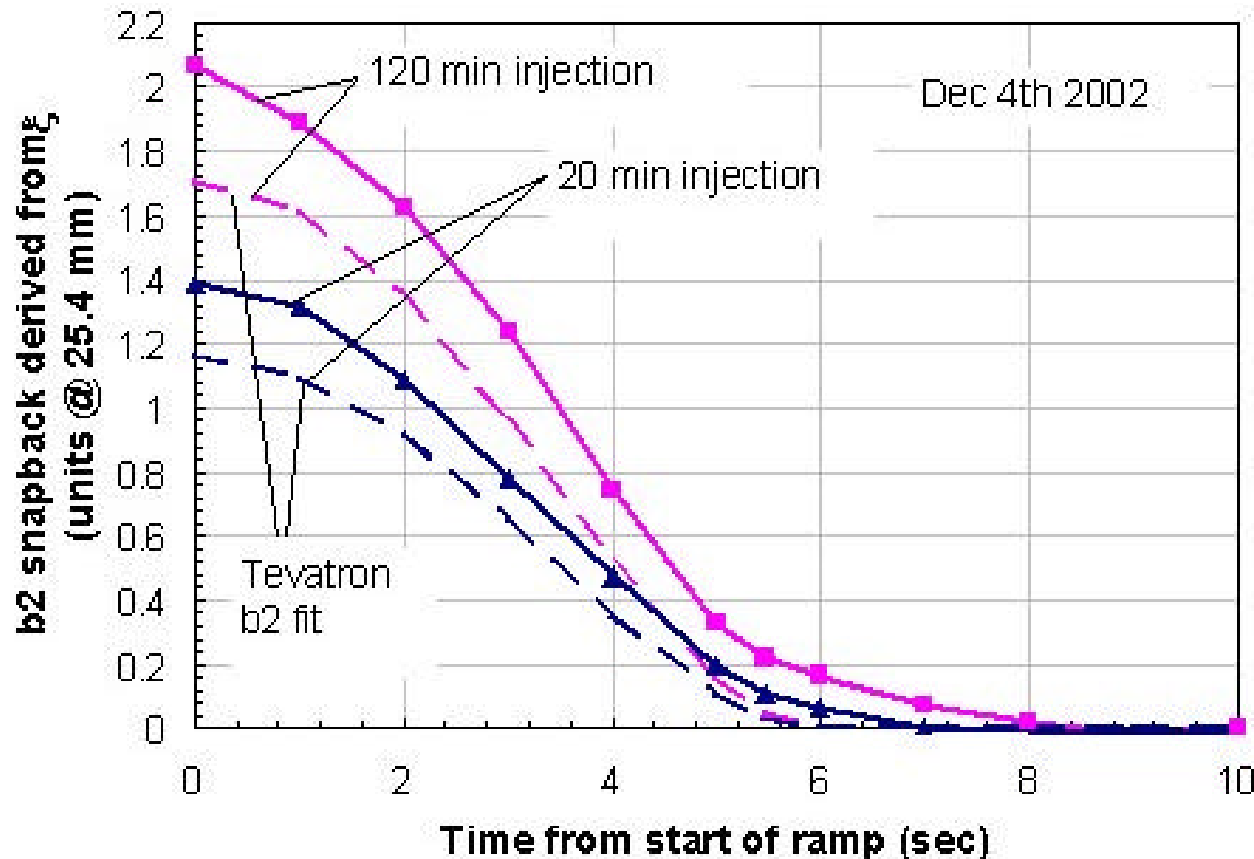
**b2 D&SB after 30 min injection  
porch for a standard pre-cycle in  
5 Tevatron dipoles (note change  
of scale on abscissa)**

Time (sec)

- time-structure of SB
- drift amplitude
- magnet-to-magnet spread in dynamic effects



## **Beam Based Measurements – Dynamic b2**

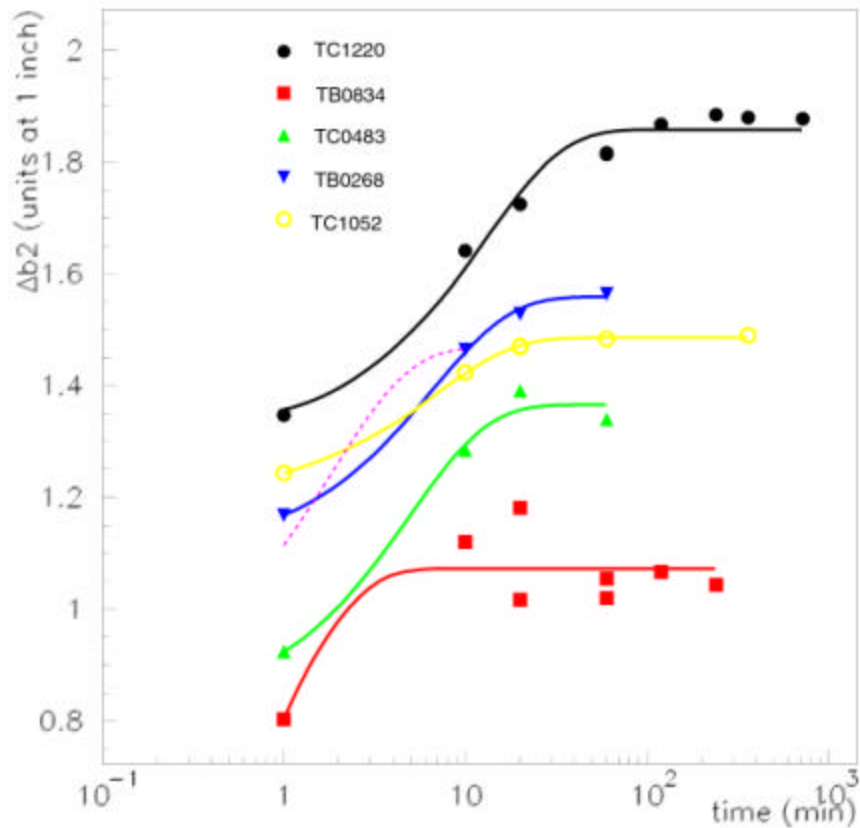


- **Measured SB longer than predicted by fit**
- **drift amplitude larger than predicted by fit**

**Average Tevatron dipole b2 SB after 20 & 120 min injection porch, derived from measured beam chromaticity (dashed: b2 compensation)**

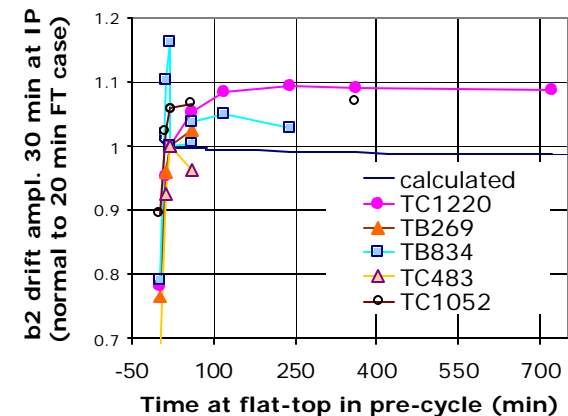
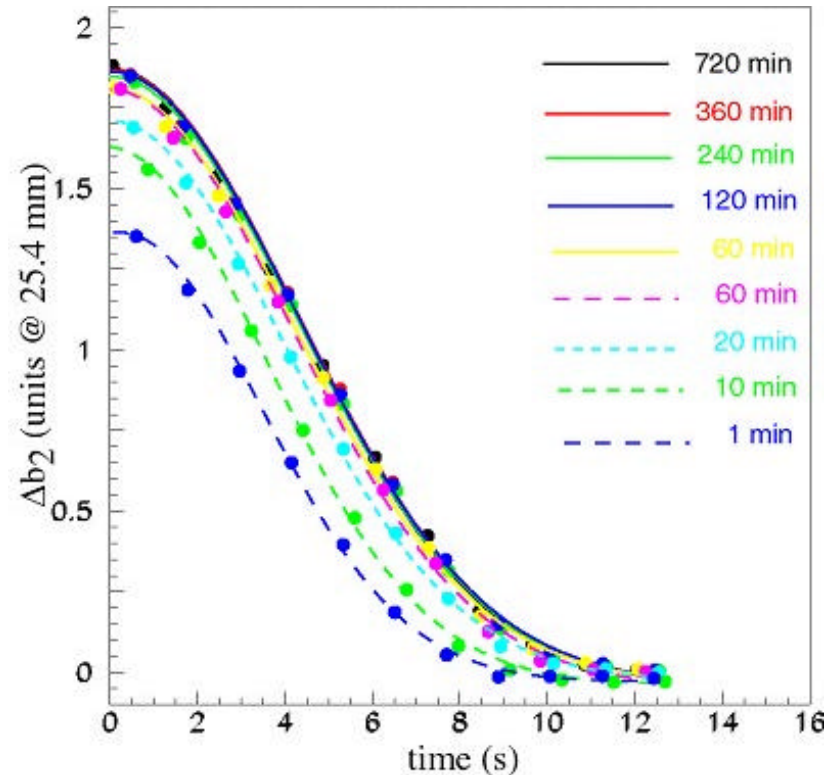


# **Effect of Pre-Cycle Flat-Top Duration on Dynamic b2**



## **b2 drift amplitude in 5 magnets**

## **SB in 1220 for diff. FT durations**







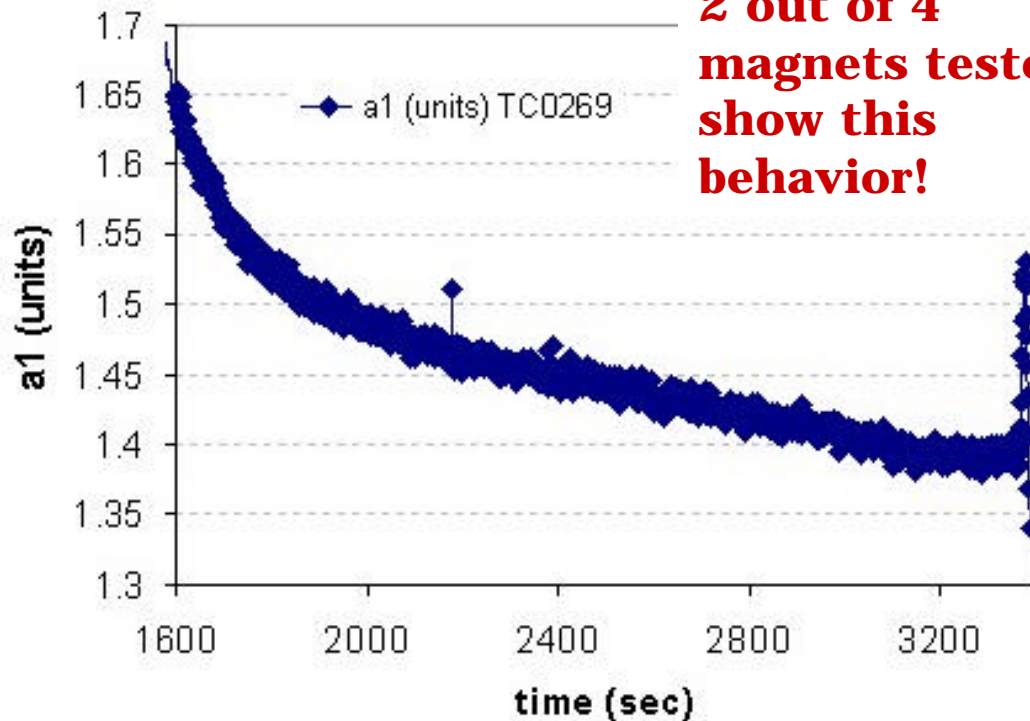
## **Magnetic Measurement: Dynamic $a1/b1$**

**Possible magnet borne causes of tune/coupling drift:**

- 0.1 units of  $a1$ ,  $b1$  drift in all dipoles**
- 2 units of main field drift in quad magnets**

**2 out of 4  
magnets tested  
show this  
behavior!**

**® Progress on  
characterization of  
 $a1$  drift...**

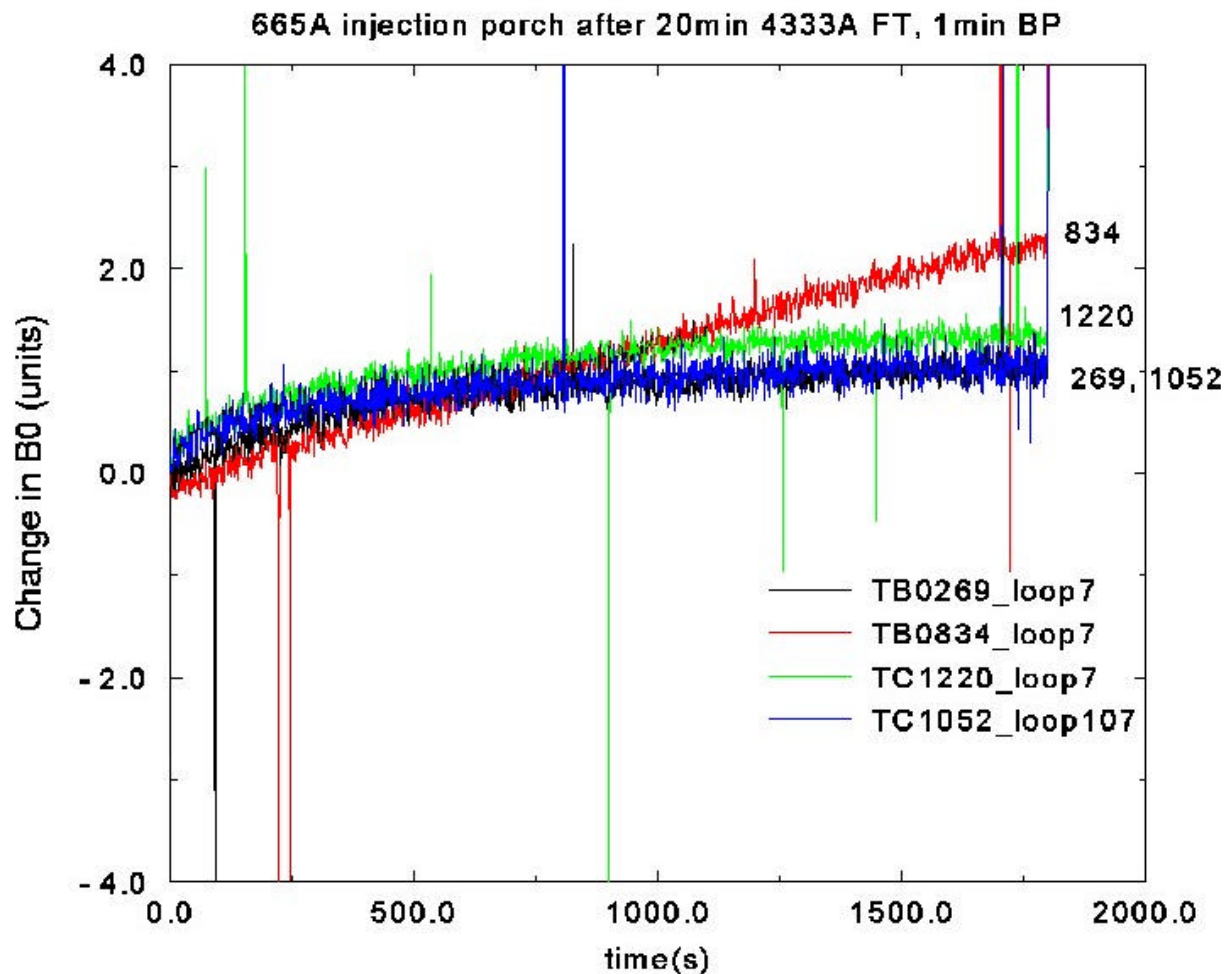


**$a1$  drift in Tevatron  
dipole 269 during the  
injection porch  
following a standard  
pre-cycle**



## **Magnetic Measurements: Main Field Drift**

**First evidence of main field drift in Tevatron dipoles:**



**•b0 drift  
amplitude  
dependence on  
pre-cycle  
parameters  
similar to b2 drift**

**•b0 drift  
amplitude  
correlated with  
b2 drift  
amplitude**

**B0 drift at injection in 4 dipoles after standard pre-cycle.**

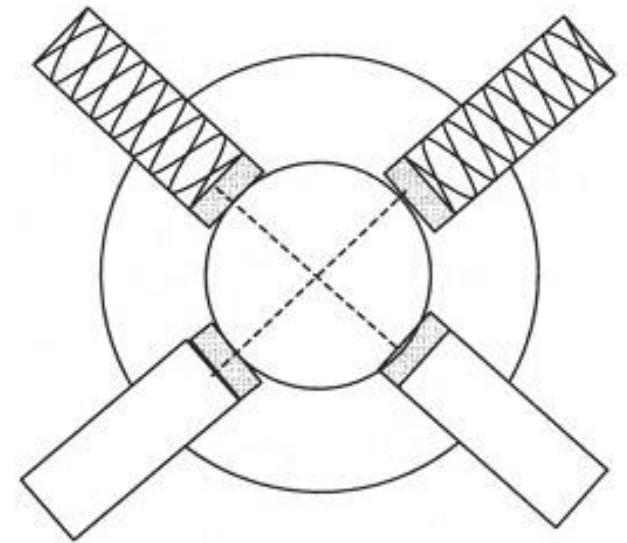




## **Magnetic Measurements: a1 Issue**

**a1 ® strong coupling, possibly caused by dropping of coil in yoke that occurred during first years of Tevatron operation;**

Magnet	D in cold lift 82-02 (mils)	D in a1 82-02 (units)
TB0269	+8.5 / +7.0	+1 *
TC1220	+4.1 / +6.0	+1 *
TB0834	+11.3 / +11	+3 *
TC0483	+4.2 / +6.2	+0.4 *



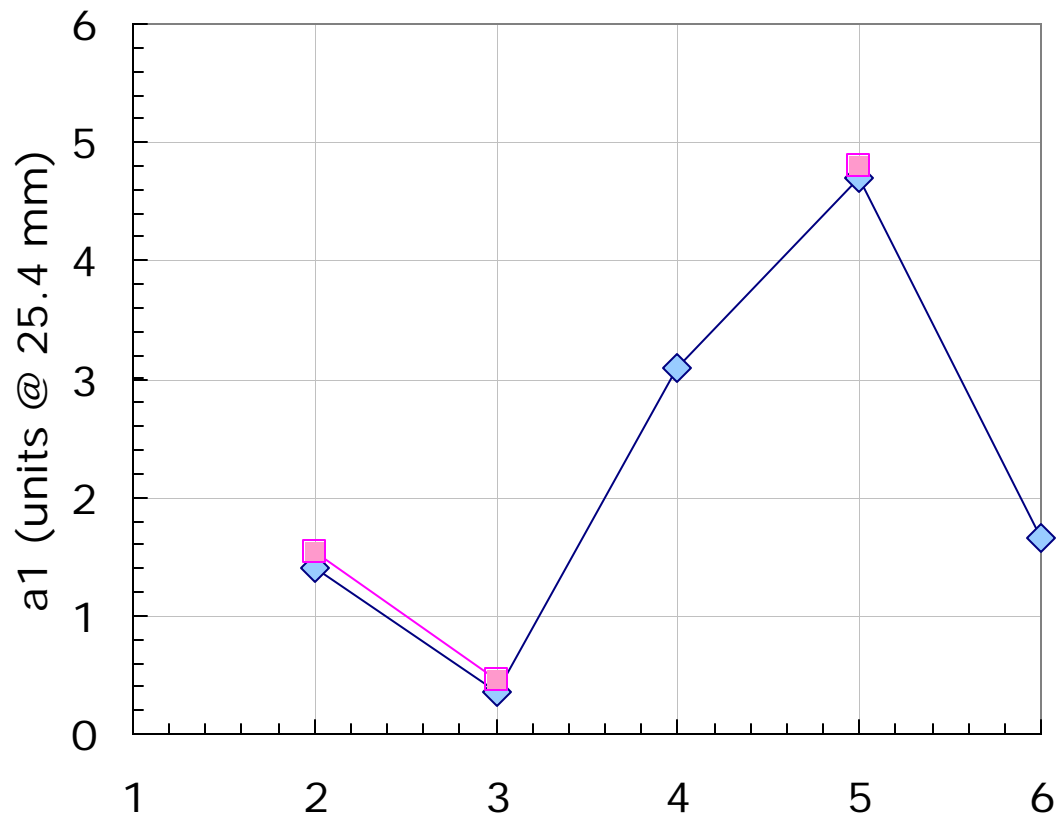
**\* 82 and 02/03 measurements were performed with different rotating coil assemblies in different positions of the magnet body. Therefore data are suggestive but conclusions cannot be drawn yet ® variation of a1 measurements along magnet length, change in b1 appeared also!**



## *Longitudinal variations of $a_1$*

### Possible causes:

- Variations of coil position with respect to yoke
- Coil shape variations, especially between lower and upper pole



**Plot of geometric  $a_1$  along axis of magnet 0525.**

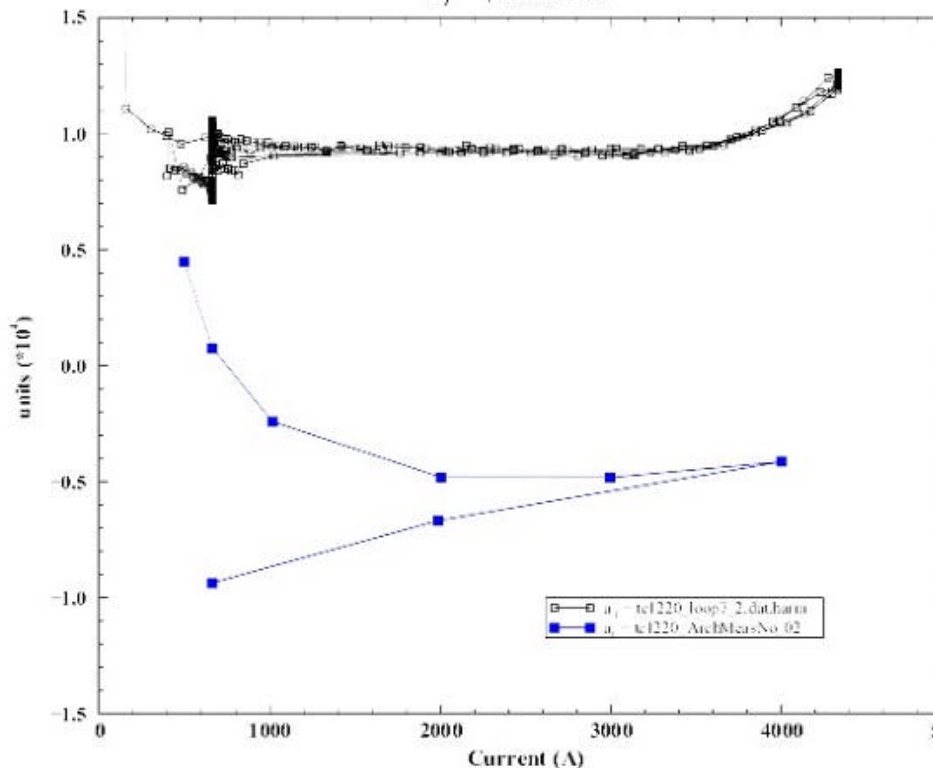


# Magnetic Measurement: $a_1$ During Ramp

06: newHarmData tc1220 a1b1\_comp\_0205881315.png

Tevatron Dipole Harmonics Data

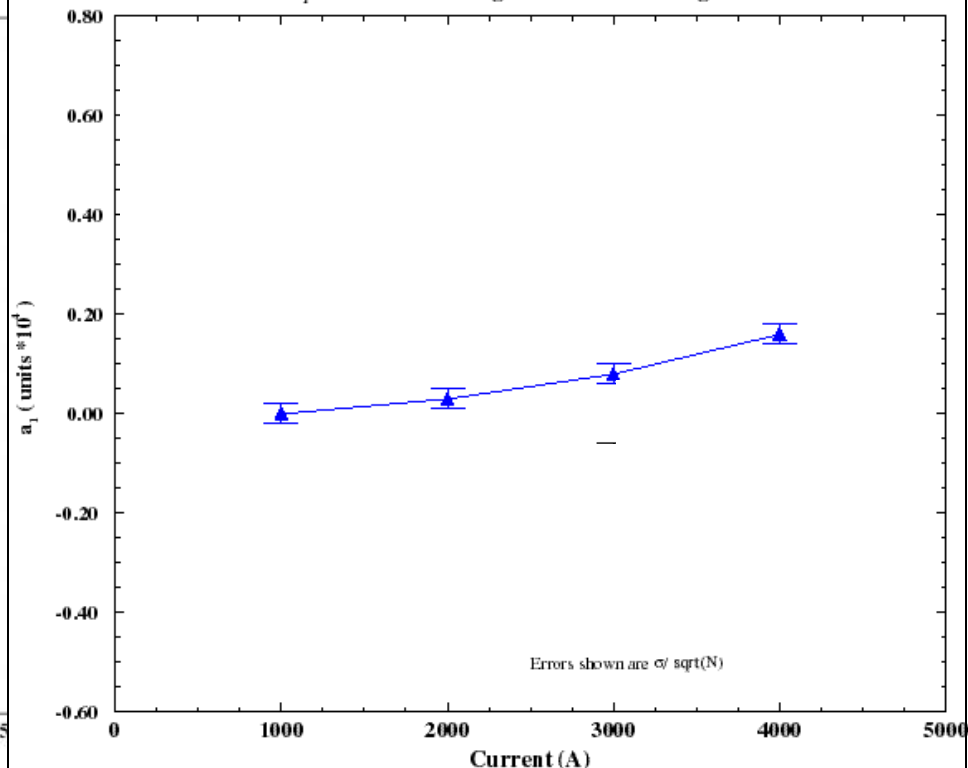
$a_1$  vs. Current



05 May 2003 13:43:14

Tevatron Dipole Archival Data

$a_1$  vs. Current Average Over Installed Magnets



**$a_1$  vs current in TC1220, measured in 82 & 03.**

**average  $a_1$  vs current of all dipoles installed (archive data).**



## **Other Activities:**

### **Re-shimming – Demonstration experiments:**

- 3 dipole magnets were re-shimmed and a1 measured along the length – before/after re-shimming® procedures developed for re-shimming in tunnel,

### **Re-rolling experiments:**

- Rolling of dipole in string to verify if roll correction can be performed in tunnel without damaging the magnet vacuum. Also tested: if coil rolls back with the yoke.....experiment currently in progress

### **Towards on-line Tevatron field diagnostics:**

- hardware development launched including design of fast DSP/ADC based system, long warm-bore and new probes



## **Achievements - Summary**

- **improved b2 snapback fit proposed ® Gaussian shape, longer snapback-time**
- **Improved b2 drift amplitudes ® exponential b2 fit?**
- **saturation of flat-top duration effect on drift amplitude ® foundation for elimination of pre-cycle**
- **a1 issue – progress on model for a1 in dipoles**
  - **a1/b1 drift: first evidence found**
  - **main field drift: first evidence found**
- **re-shimming demonstration experiment**
  - **re-rolling experiment started**
- **magnetic measurement hardware for reference magnet system started**